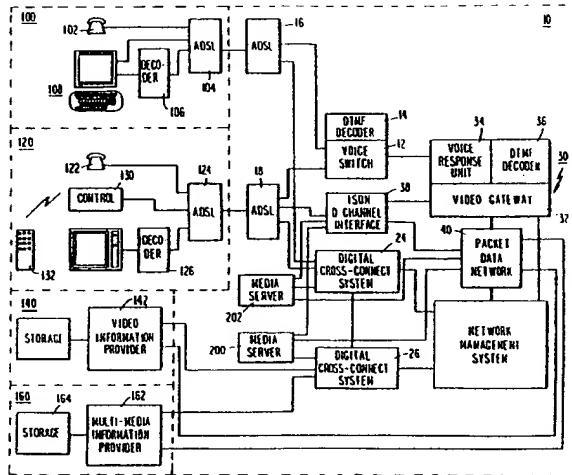




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(54) Title: MEDIA SERVER FOR SUPPLYING VIDEO AND MULTI-MEDIA DATA OVER THE PUBLIC TELEPHONE SWITCHED NETWORK



(57) Abstract

A media server (200, 202) receives, stores and forwards multi-media data and full motion video feature presentations within a PSTN. The media server (200, 202) receives wide band digital video and MPEG encoded video signals. The wide band digital video is encoded using either a real time MPEG encoding for immediate transmission over network facilities to subscribers (100, 120) or using a multi-pass MPEG encoder for storage by the Media Server (200, 202) for subsequent transmission. The Media Server (200, 202) includes DRAM (278), optical and magnetic disk storage (282), high speed tape storage (286) and archival storage (290). A Librarian Processor (250) allocates storage space on a media appropriate to retrieval requirements for the video data. The Librarian is responsive to a storage Manager Processor (270) and a Session Manager Processor (310) for providing video program data to an Output Controller (330).

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MEDIA SERVER FOR SUPPLYING VIDEO AND MULTI-MEDIA
DATA OVER THE PUBLIC TELEPHONE SWITCHED NETWORK

Technical Field

The invention relates to a data storage distribution system using the Public Switched Telephone Network (PSTN), and, more particularly, to a media server for supplying stored image, video and audio data to local subscribers over a PSTN.

Background Art

Video programming options have experienced rapid growth with advances in communications technology. Recent trends have been directed to user definition of programming, with each system subscriber specifying the programming to be provided. Such a system is described in related co-pending application Serial No. 07/766,535.

In addition to conventional full-motion video programs, advances in personal computer capabilities have created increased demands on data base sources to supply information to households and business. Corresponding increases in data availability, storage, retrieval and transmission capabilities have supported recent growth multi-media data presentation of information. Multi-media presentations include, in addition to conventional text, still-images, animation, slow and fast scan video, and graphics format visual

presentations. Multi-media also includes sound data presented in concert with, or independent of, one or more of the listed visual presentations. A multi-media presentation can range from the equivalent of an 5 electronic book including plain text in combination with still images to full motion video presentations of feature movies. Thus, multi-media spans a wide spectrum of data storage, retrieval and transmission requirements to present information in various formats 10 to system users.

As described, multi-media includes full motion video presentations. Various systems have been suggested to selectively provide a user with requested 15 video programming. These systems are sometimes referred to as programming-on-demand and impulse pay per view. Monslow et al. U.S. Patents Nos. 4,890,320 and 4,995,078, respectively issued December 26, 1989 and February 19, 1991. These patents disclose a television broadcast system for real-time transmission 20 of a viewer-chosen program at a viewer requested time to the requesting viewer's television receiver. The system comprises a program collection, which stores TV programs on a video tape. Each program is assigned and labeled with a catalog number.

A viewer request is transmitted using a conventional telephone over the PSTN to a scheduling computer. The chosen program is transmitted at the requested time over a broadband cable for viewing on the requesting viewer's television receiver. A control 25 unit prevents other households connected to the cable 30 from viewing the program.

Cohen U.S. Patent No. 4,949,187 issued August 14, 1990 describes a video communication system comprising a remotely controlled central source of video and audio

data. This system allows home viewers to select from a choice of movies or other video and audio data that may be transmitted from the central source to be stored at the viewer's premises. The viewer can play the 5 selection at any convenient time of his choosing. The central source may store the data digitally. Movies that need to be frequently accessed are stored on disks. Movies that are accessed only infrequently are archived. A distribution system CPU controls the 10 bidirectional flow of data from both types of drives. Several movies can be transmitted simultaneously to different users through a plurality of input/output controllers. To make use of a single transmission media, such as a telephone line, a multiplexer is used, 15 which may multiplex in the time domain or the frequency domain.

Etra U.S. Patent No. 5,012,334, issued April 30, 1991 discloses a video image bank for storing a plurality of video image sequences. The bank provides 20 a visual effects set for video production. The bank includes a library of video disks with an associated library index. A microprocessor is loaded with the library index. Groups of still frames, one from each identified image sequence, are displayed and an 25 operator selects any one of the represented image sequences for addition to an edit tape and associated edit list prepared by the bank.

Ciampa et al. U.S. Patent No. 4,635,136, issued January 6, 1987 discloses a massive inventory of 30 labeled images, which are stored in a digital form. A TV signal for each image is generated by a video camera. Stored digital information defines the route for a video camera to each site where a video image is recorded.

Lambert U.S. Patent No. 4,381,522, issued April 26, 1983 discloses a cable television system which includes a plurality of selectable video signal sources having selectable television program material.

5 The system enables a viewer to select desired program material available by telephone at a remote location and have the selected material promptly available for viewing. A minicomputer stores information on the program source location, the status of the selected 10 program source, the available channels and the schedules for each.

Walter et al. U.S. Patent No. 4,513,390, issued April 23, 1985 discloses an information system for storage, retrieval and generation of information from a 15 plurality of multi-media sources. The system uses a plurality of source inputs and a plurality of data outputs, all under the control of a common computer that is operative along a common data bus. Included as source inputs are stored memory data, hard copy, 20 microfiche and direct operator entered data.

Pocock et al. U.S. Patents Nos. 4,734,764 and 4,941,040, issued respectively on March 29, 1988 and July 10, 1990 disclose cable TV systems for distributing pre-recorded video and audio messages, 25 which comprise a remote storage device. The video is presented as still frames, which are stored in a multiple node frame store. A video frame has one of the scan lines in its video blanking signal uniquely addressed.

30 Nakajima et al. U.S. Patent No. 4,538,176, issued August 27, 1985 discloses a video/audio transmission system, which sends video and audio information from video and audio files at a center to a subscriber . .

through at least one subcenter having a video/audio buffer memory.

5 Walter U.S. Patent No. 4,506,387, issued March 19, 1985 discloses a programming-on-demand cable system, which allows any one of a plurality of users to request any one of a plurality of video programs from a library of programs. The programs are stored in memory devices selectable by a host computer at a central data station in response to an address signal transmitted from the 10 user. Upon request of the viewers, the programs are transmitted at a high non-real-time rate over a fiber optic line network. Optical data is then reconverted to electrical data and stored for broadcast to the viewers.

15 McCalley et al. U.S. Patent No. 4,829,372, issued May 9, 1989 discloses a presentation player which is utilized in a digital, interactive communication system accessible to a plurality of subscribers who can select any of a plurality of pre-recorded video/audio 20 presentations for viewing on their TV sets. The system includes a large scale data base, which stores digital information including still frame images and textual information in hard disk memory units.

25 Beaulier U.S. Patent No. 4,821,121, issued April 11, 1989 discloses a still image store system, which stores and selectively outputs video image data. A random access frame store receives input video data converted into digital form and transfers the data to a disk store for more permanent storage. Full size data 30 and reduced size data of the same video image are stored.

Bohn U.S. Patent No. 4,888,638, issued December 19, 1989 discloses a marketing research system for substituting stored TV programs for regularly

scheduled, broadcast TV programs. The substitute TV programs may be transmitted from a central office via telephone lines to households of cooperating panelists for storage at the household premises.

5 While providing multiple data formats from a data base to a user, these prior art systems do not integrate network control functions to provide a high speed data link between major nodes narrow band encoded data from nodes to remote users. In particular, prior
10 art systems are not responsive to individual user requests for providing high speed data connectivity from a data source to a node serving one or more users and selectively scheduling and supplying requesting users with programming.

15 Related copending application serial number 07/766,535 filed September 27, 1991 describes Video-On-Demand (VoD) Services that provide video programming to subscribers over the public switched telephone network (PSTN). A menu of video programming information is
20 accessible at the subscriber's premises. The subscriber may transmit ordering information via the PSTN to independent video information providers. Video programming may be accessed and transmitted to the subscriber directly from a video information provider (VIP) or through a video buffer located at a
25 central office (CO) serving the subscriber.

The VIP transmits coded digital video data over wideband PSTN supplied connectivity to a central office. The video data may be buffered at the central office for transmission over a POTS line to the subscriber. A subscriber may use either a standard telephone instrument over the PSTN or a dedicated control device over an ISDN packet network to order the video programming. Such a device is located at a

television set of the subscriber and permits a display of the program menu on the television screen.

Connectivity between the central office and the subscriber for transmission of video data is provided by an asymmetrical digital subscriber line (ADSL) system. ADSL interface units perform frequency multiplexing of digital video information with voice information to be transmitted to the subscriber and support transmission on the ISDN packet data network of a reverse control channel from the subscriber to the central office.

However, the Video-on-Demand system does not include an integral library of video program material, nor does it support integration of several sources of programming material to provide a multi-media or mixed media presentation. The VoD buffer includes limited storage capabilities for video and audio data supplied by a VIP. Enhanced functionality is required to support multiple program storage and to integrate data from various data bases to provide composite programming required for multi-media and mixed-media presentations.

To support network management, a need further exists for a system which dynamically interacts with network facilities to reconfigure network resources in real-time and in response to information requests. A further need exists for a library system for accessing and retrieving multi-media programming from storage and from independent information providers in response to user requests and transmitting the data over wide bandwidth links to a node serving a user.

Accordingly, an object of the invention is to provide a library of multi-media data including video programming on demand using components of the PSTN.

Another object of the invention is to provide subscriber access to multiple sources of combined image and textual programming over the PSTN.

5 Still another object of the invention is to provide real-time subscriber control of multi-media and video programming delivery.

10 A still further object of the invention is to provide a selected video program to a subscriber within a predetermined short processing interval after initiation of a request.

Disclosure of the Invention

15 According to one aspect of the invention, a media server for supplying multimedia data includes a user request processor responsive to a user request for supplying information request data. A session controller is responsive to the information request data for supplying information retrieval data and output control data. A data storage device is responsive to the information retrieval data for 20 supplying program data. An output controller, responsive to the output control data, supplies the requested multimedia data. The multi-media data may include text, still images, graphics, low and high resolution partial and full motion video and audio.

25 The output controller includes transmission circuitry for transmitting the multimedia data to remote end users. According to a feature of the invention, a public switched telephone network is responsive to the output control data from the session controller for supplying the multimedia data to remote 30 end users. The user request data is supplied to the user request processor means by the public switched telephone network.

According to another aspect of the invention, the user request processor includes a transmission receiver for receiving the user request data from a remote end user. The user request data is supplied to the 5 transmission receiver by a public switched telephone network.

In accordance with another aspect of the invention, the data storage device includes a plurality of storage media for storing the program data. The 10 data storage device may include both optical and magnetic memories and may further include three different storage media having substantially different respective information retrieval times.

According to another aspect of the invention, the 15 session manager includes an output port selector responsive to the user request data for supplying output port assignment data and a memory for storing session status data. The memory includes a table for storing output port assignment data, input port 20 assignment data, and program status data.

According to another aspect of the invention, the media server includes a program storage librarian responsive to the information retrieval data for supplying program priority data of respective program 25 data, the data storage device responsive to the program priority data for storing the program data.

According to another aspect of the invention, a random access storage unit provides storage of the program data.

30 According to another aspect of the invention, a program data input controller is responsive to the session controller for supplying real-time program data to the data storage device. A video data encoder receives the real-time program data and supplies

encoded video program data to the data storage device and/or to the output controller for immediate distribution.

According to another aspect of the invention, the
5 session controller includes session registers for storing dynamic frame location data indicating a current frame position of the program data. The session controller may further include a memory for storing a session routing table having program data
10 routing data and program source data for active users.

According to another aspect of the invention, the session controller is responsive to user address and file selection data for supplying network configuration request data. The user request processor may include
15 security processor for storing user access data and, responsive to the user access data, selectively supplying the information request data to the session controller.

According a feature of the invention, the user
20 request processor can detect a user control link failure. The user request processor may further include an audio response unit for receiving the user request data and for supplying audio responses to a requesting user and a program catalog processor
25 responsive to the user request data for supplying the program catalog data to a requesting user.

According to another aspect of the invention, the user request processor means supplies the user request data to a multi-media processing means for supplying information retrieval data to the data storage means.
30

The media file server system handles requests received from a Video Services Gateway and provides a video file feed to the customer via the network link. In addition to Video-on-Demand capability, the server

5 supports other user highly interactive multimedia applications. The server is a file management system responsible for inputting video files from video and multimedia information provides storing these files or
10 passing the real-time data through to the user, keeping track of the user's session, handling all interactive control requests from the user, and controlling all output to the user.

10 The system comprises an input controller, Q.931, X.25, T1 and DS-3 interfaces, a librarian, a storage manager, a session manager, an output controller, an interactive processor, and a multi-media application processor. The librarian provides file functions including distribution of video, audio, stills, and
15 text selections to the session manager and the multi-media application processor at the request of itself and the multimedia application processor. The librarian keeps track of the storage location of all multimedia selections and catalogs and stores all
20 incoming files from VIPs. The librarian records access history for determining statistical usage and trends. This information is used for, among other things, designating frequently used features for assignment to rapid access highly addressable storage. Various
25 storage modules of differing capacity and access speed are provided.

30 Storage format is MPEG encoded digital video, received from the VIPs, or D1 digital video, which is MPEG encoded by the server processor and stored in MPEG format. The processor provides appropriate interface with intelligent protocol.

The above and other objects, features and advantages of the present invention will become

apparent from the following description taken in conjunction with the accompanying drawings.

Brief Description of Drawings

Figure 1 is a block diagram of a multi-media programming distribution system including a media server according to the invention integrated in a public switched telephone network.

Figure 2 is a simplified block diagram of a media server according to the invention.

Figure 3 is a detailed block diagram of a media server according to the invention.

Figure 4 is a block diagram of program storage facilities of the media server according to the invention.

Best Mode for Carrying out the Invention

The overall Video-on-Demand and Multi-Media distribution service platform shown in Figure 1 uses existing components of the Public Switched Telephone Network (PSTN). The system supports storage and distribution of conventional full motion video programs ("features") such as movies at user request, i.e., Video-on-Demand (VoD). Also supported are Multi-Media presentations and processing, including combinations of text, still images, and full and partial motion video.

Video may include interactive activities such as training applications, games, shopping, etc.

The Media Server uses compression techniques to store video and other multi-media data in memory resources controlled by the Media Server for subsequent forwarding over interoffice facilities. The switching facilities are located in Central Offices (COs) serving residential customers or subscribers. Loop electronic

devices modify the transmission characteristics of the local copper loop, to provide required enhancement to the PSTN and permit delivery of full motion video information and other media.

5 High data rate types of multi-media data are encoded to conserve system resources. For example, analog video information is first converted to a digital format using encoding algorithms standardized by the International Standards Organization (ISOs)
10 Motion Picture Experts Group (MPEG). Each title comprises video information stored by the Media Server as an addressable data file in conventional data processing devices functioning as a video library. The function of establishing and monitoring connections
15 linking a video library port transmitting selected information with the end user ports receiving the information is performed by a supervisory controller such as a network control system, e.g., FLEXCOM software, used to control the electronic digital cross-connect switches (DCS) in the PSTN. The DCS, also used for switching two-way DS-1 rate transmissions, is adapted to additionally provide bridging or broadcast of video information to several users. Data session control between a video library port and a remote user
20 one of the functions performed by the session manager of the Media Server.
25

The network control software of the Media Server in combination with management resources of the PSTN (i.e., FLEXCOM/LINC or other Network Management System)
30 control the "network session" between an Output Controller of the Media Server, external program providers, and user ports. The session manager also maintains a record of relevant data regarding each

session which is forwarded to a customer billing system.

Customer local loops equipped with Asymmetric Digital Subscriber Line (ADSL) devices are connected to the DCS. The multi-media distribution system provides for the simultaneous transport of a one-way 1.544 megabit per second (MBPS) signal over the same twisted pair transmitting voice messages to the residential subscriber. The ADSL transported signal is demultiplexed and the 1.544 portion is then decoded using MPEG standard techniques to deliver a full motion video signal. In the PSTN, fiberoptic technology will replace existing coaxial and twisted pair connectivity with corresponding enhancements made to switching and routing equipment.

Referring to Figure 1, a multi-media system includes CO equipment 10 which is part of a PSTN. CO 10 provides connectivity from information providers 140 and 160 through the system to Media Servers 200 and 202 to Multi-Media subscriber 100 and VoD subscriber 120.

CO equipment 10 includes a conventional voice switch 12 which includes means to detect off-hook, service requests, call completion (*i.e.*, ring trip), a DTMF decoder 14 and dial pulse detector. Voice switch 12 also includes an actual telephone call connection switch for routing voice circuits among the various ports. The CO equipment shown may be physically distributed over several sites.

Connected to voice switch 12 are ADSL equipment 16 and 18 for multiplexing (i) voice and signaling information from voice switch 12 and (ii) digital multi-media data from Digital Cross-Connect System (DCS) 24 onto respective subscriber local loops 20 and 22. Multi-media data from multi-media information

providers 140 and 160 is provided to DCS node 26 where it is selectively supplied to Media Server 200 or immediately transmitted to DCS node 24 under control of Network Management System 28.

5 In addition to providing pre-stored video and multi-media programming, the Media Server accepts video and multi-media programming from video and Multi-Media Information providers 140 and 160 for later transmission and for real-time and multi-pass MPEG
10 encoding. Real-time encoding is used to provide encoded full motion video while minimizing network transmission requirements and providing a signal compatible with ADSL connectivity to subscriber premises 100 and 120. Multi-pass encoding performed by
15 the Media Server provides a higher quality video signal for storage and later transmission over the network to subscriber premises 100 and 120.

ADSLs 16 and 18 multiplex data on subscribers loops 20 and 22 using frequency multiplexing, dividing the available loop bandwidth into three segments. Base band audio and signaling below 4 kilohertz (kHz) provides connectivity for a conventional telephone services available on the "plain old telephone system" (POTS). Alternatively, ISDN channel requirements consume the bottom 80 kHz of loop bandwidth. Reverse channel digital packet information is positioned between 80 and 90 kHz providing approximately 16 kilobits per second (kbps) connectivity from the subscriber premises to a packet switched network such as ISDN network over a D-channel interface. Compressed video and multi-media data is contained between 100 and 400 kHz to provide a 1.6 MBPS channel for transporting the video and multi-media data over respective loops 20 and 22 to customer premises 100 and 120.

The Media Server is shown in further detail in Figure 2.. The Media Server system processes all requests from Video Gateway 30 for providing multi-media and video file feeds to customer premises via the 5 DCS and ADSL systems.. The Media Server preforms input of video and other information files from Video Multi-Media Information providers 140 and 160, stores these files or passes real-time data through to subscribers 100 and 120, monitors and records user sessions, 10 processes all interactive control requests from users, and controls all output to the user.

The Media Server also processes and supplies multi-media services including interactive learning, interactive games, and other presentations. The Media 15 Server stores and processes all data required for the multi-media applications including text, still pictures, audio, and partial and full motion video, as well as interactive application scripts.

The Media Server includes eight major component 20 systems: Input Controller 210, Q.931 ISDN Interface 230, Librarian 250, Storage Manager 270, Session Manager 310, Output Controller 330, interactive processor 350 and multi-media application processor 370.

25 Input Controller 210 includes a plurality of DS-3 Input Ports 212 for receiving multi-media data including digitized video in the form of MPEG encoded digital video signals and unencoded video. D1 digital video is supplied to Librarian 250 for MPEG encoding. 30 Video supplied in MPEG encoded format is supplied to Session Manager 310 for storage by the Media Server or for immediate transmission by output controller 330.

Q.931 Interface 230 provides connectivity between Interactive Processor 350 and ISDN D Channel Interface

38 (Figure 1). Interactive Processor 350 receives command data over the ISDN from subscribers running interactive programming from the Media Server. Interactive programs include Multi-media presentations and video games. Interactive Processor 350 also receives command data from subscriber control unit 130 for interactive control of feature presentations (i.e., conventional video programming including movies, concerts, etc.) including pause, fast-forward, reverse, and other "VCR" type capabilities supported by the Media Server. These latter commands are passed to Session Manager 310 for further processing and control of the video programming.

Data to be stored or retrieved from memory is first routed through Librarian 250 and, under its control, Storage Manager 270 either stores the program data or retrieves and provides previously stored program data to Output Processor 330.

Media Librarian 250 controls distribution of video, audio, still image data and text selections to Storage Manager 270 in response to information requests from Session Manager 310 and Multi-Media Application processor 370.

Referring to Figure 3, the Librarian further monitors and record in Feature Index System 252 the storage location of all video selections for VoD and Multi-media applications. The Librarian also records a history of access to video programming, i.e., "features", and to other data provided during each twenty-four hour period in Usage Data Accumulation System 260. The usage data is supplied to Usage Probability Processor 262 to establish an intelligent cache using DRAM Storage 278 for rapid access and highly addressable storage of features.

5 Feature Index System 252 maintain a catalog of data and support processing for storing all locally stored programs. This includes the allocation of storage media type and space, maintenance of addressing tables for program status and frame indices, and maintain an index for all volumes. The program listing data is supplied to a menuing system supported by Video Gateway 30 (Fig. 1) via Packet Data Network 40.

10 Feature Index System 252 performs catalog maintenance functions including input of new feature program data into the system, ageing, and deletion or archival of aged program data. New program data from Video and Multi-Media Information Providers to be stored by the Media Server are received via a DS-3 port 212 of Input Processor 210. The catalog maintenance system determines the priority of the incoming program data and allocates appropriate storage to the data. Once the file space is allocated and the file is stored, the volume indexes are updated, the frame positions of the program are calculated and frame addressing tables are created and stored. The frame addressing tables are used to address a feature from any position in the feature.

15 When it is determined that a stored feature is no longer required, Media Librarian 250 removes the program data from the file catalog. The record to be deleted is then flagged by a system administrator of Storage Allocation Processor 272.

20 Librarian 250 tracks frequency of feature access. As a feature is requested less frequently, it is "aged" by the Media Server. Usage Probability Processor 262 assigns a priority value to the feature which is used to determine the appropriate storage type to maximize system resources while providing acceptable access time

to the feature based on its demand history. Once a feature is aged to a point of not having been requested within a predetermined time period, the Media Server removes the program from on-line storage units 278, 282 and 286 and places it in archival storage 290. The feature header data remains stored in Feature Index 252, although access time for the feature will be increased.

The catalog system updates feature titles data as the features are loaded into the Media Server. The updated catalog information is supplied by Librarian 250 of the Media Server to Video Gateway 30. The data supplied to the Video Gateway is shown in Table 1.

| <u>ELEMENT</u> | <u>USE</u> | <u>ORIGIN</u> | <u>TYPE</u> |
|--|--|--|---------------|
| Feature Title | To be used by the menu system to update the list of features provided for the users. | Video information provider or programmer | Alpha/Numeric |
| Feature Index Number | Used by the Gateway when transmitting a request to the server. | Librarian | Integer |
| Priority | Used by the Gateway to determine the set-up and wait time for a feature. | Originally determined by the feature box office ranking. Subsequently determined by the Trend processor. | Array |
| Feature Length | Used for schedule processing by the Gateway. | VIP | |
| Key Actor/Actress, Author, Director, Subject | Used by the Gateway for performing searches on the elements listed. | VIP | |
| Motion Picture Association Rating | Used by the Gateway for feature type blocking based on rating: G, PG, PG-13, R, NC-17, XXX | VIP | |
| Category | Used by the Gateway Menu processor to determine the placement of the title. | VIP | |

TABLE 1

Alternatively, according to a preferred embodiment of the invention, menu data is retained in the Media Server and downloaded to user customer provided equipment (CPE) for viewing and selection or transmittal to the user directly for processing.

Usage Probability Processor 262 statistically determines features having the highest probability of usage on a per hour and day of week basis to properly allocate high order storage, i.e., DRAM Storage 278, on an hourly basis. In support of this function, Usage Data Accumulation Memory 260 stores tables of data including time of viewing, day of viewing and cumulative number of requests that are updated each time a feature is supplied.

Allocation of storage in the Media Server is based on the ranking of a feature and the output of the trend processing performed by Usage Probability Processor 262. Referring to Fig. 4, storage is divided into several components, including DRAM 278, Magnetic Tape 290. All features are stored on the appropriate media based on the priority ranking of the feature. For example, DRAM Storage 278 is used for the highest priority features as determined by the trend processing whereas Archival storage is used for the lowest priority features. Table 2 gives typical priority assignments and storage capabilities of each media.

| <u>PRIORITY</u> | <u>NUMBER OF FEATURES</u> | <u>STORAGE</u> |
|-----------------|---------------------------|-----------------|
| 1 | 20 ± 5 | DRAM |
| 2 | 100 ± 3- | MAGNETIC DISK |
| 3 | 300 ± 50 | HIGH SPEED TAPE |
| 4 | 500 + | ARCHIVAL TAPE |

DRAM Storage 278 is used for the highest twenty features and data files as determined by the trend processing. When a feature or other high priority media file is stored in DRAM it does not occupy magnetic storage space until removed from DRAM storage. A compressed feature length movie of 90 minutes duration occupies approximately 1.2 gigabytes of DRAM storage.

Disk Storage Units 282 are fast access magnetic and/or optical media providing storage for the second highest fifty priority features and media data files as determined by the trend processing. When a feature is stored on a Disk unit, it does not occupy DRAM or Tape Storage until removed.

High Speed Tape Storage Units 286 store features and multi media data files having a medium priority as determined by the trend processing. Finally, Archival Tape Storage is used for the lowest priority features and media data files.

Storage Channel Management Processor 274 controls flow of data between all storage devices and Output Control Processor 330. Input Control Processor 210 receives multi-media and feature program data from Video and Multi-Media Information Providers 140 and 160. Feature data input streams are accepted either as MPEG encoded digital video or as D1 digital video to be encoded by the Media Server. All data is either stored for play at a users request or passed directly through to the user as real-time programming.

MPEG encoded video data received at DS-3 port 212 of Input Processor 210 is routed to Session Supervisor

312 for storage by the Media Server or as flow-through to an appropriate output port 332 of Output Processor 330. Session Manager 310 supervises the data flow once connection from the Video Multi-Media Information 5 Provider to the subscriber is established by Input Control Processor 210 and Output Processor 330. No data is stored and no index information is supplied to Librarian 250 in the case of flow-through data.

For non-encoded data, a simplified form of MPEG 10 encoding is performed by Real-Time MPEG Encoder 390, requiring a latency of approximately ten minutes from data input to data output. Multi-Pass MPEG Encoder 392 is used for non-real-time processing, and provides full 15 MPEG encoding of video data. Both MPEG encoders receive non-encoded video data from Input Processor 210 and provide encoded video to Storage Allocation Processor 272 of Storage Manager 270. The encoded 20 video data is either stored in an appropriate storage media or transmitted by Storage Channel Management Controller 276 to Output Controller 310 for transmission to a subscriber over the PSTN.

Session Manger 310 include Session Supervisor 312 which manages all program sessions including system access by Video-on-Demand subscribers, other Multi-media users and input and output to, from and through 25 the Media server by Multi-Media Information Providers. Session Supervisor 312 tracks and records all data pertinent to each session including output port, input port (if receiving data directly from a Multi-media 30 Information Provider or if the user is a Multi-media Information Provider), feature being played or Multi-media application address, feature index data, feature frame data, and session condition. The Session Supervisor also performs network resource optimization

by the simultaneous broadcast of the same feature over one output port to multiple subscribers. However, each subscriber session is individually managed to permit interactive features such as video pause.

5 Session Trace Processor 314 tracks each subscriber's session based on feature and frame so that the execution of a pause sequence can be managed for each individual session. A subscriber may start viewing a feature as part of a larger group, with a
10 subsequent selection of a pause function placing the subscriber "out of sync" with the rest of the group. Once out of sync, a separate session is established for that user requiring Session Manager 310 to cause the Gateway to establish a new network link to the
15 subscriber's viewing location. Note that, although each user is assigned an individual logical session, sessions remaining in sync with each other share output and network facilities.

20 Session Supervisor 312 maintains a matrix of routing information for each session, including what users are assigned to a given output port, and the source of the input data: Input Port number or local storage location in use. A file play clock uses the total number of frames in a given feature to estimate,
25 by time, the frame position for that feature. This data is provided to the Session Registers 316 for tracking frames for each logical subscriber session and is used to restart an interrupted session. Session Supervisor 312 discontinues register updates upon
30 detection of a session interruption. The Session Manager 312 receives requests for initial session establishment and for file retrieval from Gateway 30 via Q.931 Interface 230 and Control Channel Filter 354.

Interactive Processor 350 processes incoming commands from subscribers sites once a session is established by the Gateway. These commands include pause or like feature for Video-on-Demand, and all response and requests by Multi-Media work stations. 5 The incoming data is interrogated for content and selectively forwarded to the appropriate module for processing: Session Manager 310 for Video-on-Demand and other retrieval applications and to Multi-Media 10 Application Processor 370 for Multi-Media Applications.

Control Channel Monitor 352 monitors each subscriber's control channel to detect a communication failure. In the event of a failure, Session Manager 310 is informed and corrective action is initiated.

15 Referring to Fig. 1, dial-up access to the Media Server in the absence of dedicated Control Unit 130 is provided by voice switch 12 which establishes connectivity with VRU 34 which answers the incoming call. The VRU prompts the subscriber for a user ID 20 which is input via the DTMF pad of telephone instrument 122. The user ID is checked and, if valid, the VRU prompts for a video selection. The video selection is then input using the DTMF pad of telephone instrument 102 which then sends the selection information to the 25 Media Server via Video Gateway 32 and Packet Data Network 40. The Media Server identifies the requested title and determines if the title is available.

If the title is found, and has not been previously 30 queued for transmission, the corresponding data file is opened and a reserve idle communications port is identified for transmission of the video data to an associated DCS node 24 or 26. Transmission of the data is delayed for a predetermined number of minutes in response to a first request for the video selection to

allow for simultaneous transmission of the video data file to subsequent subscribers placing an order for the same title within the delay period. The subsequent request orders are also placed in the queue and the 5 associated communications port ID is matched to the subscriber's network address.

After expiration of the predetermined delay, i.e., when current time equals the designated start time, the video data file is transmitted from Media Server 10 through the DCS to the designated ADSL interface 18 for transmission to subscriber premises 120. At the end of the program, a message is transmitted by the Media Server to Network Management System 28 to take the system down by terminating DCS connectivity.

15 In an enhanced version of the Video-on-Demand system, subscriber premises 120 (Figure 1) is provided with a control unit 130 for receiving data commands from remote control 132. Remote control 132 can be a conventional infrared remote control for interacting 20 with control unit 130. Data from control unit 130 is provided to subscriber ADSL interface 124 for transmission of command data to ISDN D-channel interface 38. The ISDN D-channel interface can provide initial subscriber order information directly to video 25 gateway 30 in lieu of using voice response unit 34. Once video gateway 32 identifies a subscriber request to establish connectivity with the Media Server, the address of control unit 130 is provided to the Interactive Processor 350 (Fig. 3). Upon receipt of 30 the corresponding Interactive Processor network address by control unit 130, direct connectivity is established between control unit and the Media Server 200 or 202 over packet data network 40. This connectivity permits direct data transfer between the customer premises and

the Media Server to support interactive video control used in interactive educational programming and interactive video presentations such as video games.

Control unit 130 also supports interactive control 5 of the buffered video data by transmitting appropriate commands to Session Manager 310. These controls allow the subscriber to fast forward, rewind, forward, reverse search and pause the video/audio data provided via DCS 24 to the subscribers premises.

10 VRU 34 may additionally include voice recognition capability to support voice recognition security functions and voice selection of video programming.

15 Although the present invention has been described and illustrated in detail, it is clearly understood that the same is by way of illustration an example and is not to be taken by way of limitation, the spirit and scope of the present invention being limited only by terms of the appended claims. For example, MPEG encoding may be performed by an attached processor that is part of the server architecture. Further, each component of the server architecture may reside on a separate processing platform and be closely coupled by high speed application program interfaces (APIs).

Claims

1. A media server for supplying multimedia data, comprising:

means for processing user request data, said user request processing means being responsive to user request data for supplying information request data;

5 means for controlling sessions of said media server, said session control means being responsive to said information request data for supplying information retrieval data and output control data;

10 data storage means responsive to said information retrieval data for supplying program data; and

means for controlling the output of said media server, said output control means being responsive to said output control data for supplying said multimedia data.

15
2. The media server according to claim 1 wherein said output control means comprises transmitting means for transmitting said multimedia data to remote end users.

3. The media server according to claim 1 further comprising a public switched telephone network responsive to said output control data from said session control means for supplying said multimedia data to remote end users.

5
4. The media server according to claim 3 wherein said user request data is supplied to said user request processing means by said public switched telephone network.

5. The media server according to claim 1 wherein said user request processing means comprises transmission receiving means for receiving said user request data from a remote end user.

6. The media server according to claim 5 further comprising a public switched telephone network for supplying said user request data from a remote end user to said transmission receiving means.

7. The media server according to claim 1 wherein said data storage means includes a plurality of storage media for storing said program data.

8. The media server according to claim 7 wherein said data storage means includes optical storage means and magnetic storage means.

9. The media server according to claim 7 wherein said data storage means includes three different storage media having substantially different respective information retrieval times.

10. The media server according to claim 1 wherein said session management means includes:

output port selection means responsive to said user request data for supplying output port assignment data; and

memory means storing session status data.

11. The media server according to claim 10 wherein said memory means of said session management means includes table means storing output port

5 assignment data, input port assignment data, and
program status data.

12. The media server according to claim 1 further comprising program storage librarian means responsive to said information retrieval data for supplying program priority data of respective program data, said 5 data storage means responsive to said program priority data for storing said program data.

13. The media server according to claim 1 further comprising a random access storage unit for storing said program data.

14. The media server according to claim 1 further comprising program data input control means responsive to said session control means for supplying real-time program data to said data storage means.

15. The media server according to claim 14 further comprising video data encoding means receiving said real-time program data and supplying encoded video program data to said data storage means.

16. The media server according to claim 14 further comprising video data encoding means receiving said real-time program data and supplying encoded video program data to said output control means.

17. The media server according to claim 1 wherein said session control means includes session register means storing dynamic frame location data indicating a current frame position of said program data.

18. The media server according to claim 1 wherein said session control means includes memory means storing a session routing table having program data routing data and program source data for respective active users.

19. The media server according to claim 1 wherein said session control means is responsive to user address and file selection data for supplying network configuration request data.

20. The media server according to claim 1 wherein said user request processing means includes security means storing user access data and, responsive to said user access data, selectively supplies said information request data to said session control means.

21. The media server according to claim 1 wherein said user request processing means includes means for detecting a user control link failure.

22. The media server according to claim 1 wherein said user request processing means includes an audio response unit for receiving said user request data and for supplying audio responses to a requesting user.

23. The media server according to claim 1 wherein said user request processing means includes program catalog data storage means responsive to said user request data for supplying said program catalog data to a requesting user.

24. The media server according to claim 1 further including a multi-media application processor, said

user request processing means supplying said user request data to said multi-media processing means and,
5 in response, said multi-media processing means supplying said information retrieval data to said data storage means.

25. In a public switched telephone network (PSTN) for providing multi-media data to one of a plurality of subscriber premises, including a cross-connect system responsive to control data for establishing
5 connectivity between a multi-media data base and said subscriber premises, the improvement comprising:

a media server for supplying said control data and supplying said multimedia data, including

(i) means for processing user request data, said user request processing means responsive to user request data from the PSTN for supplying information request data,

10 (ii) means for controlling sessions of said media server, said session control means being responsive to said information request data for supplying the control data to the cross-connect system and supplying information retrieval data, and

15 (iii) a multi-media data base responsive to said information retrieval data for supplying the multimedia data to remote end users.

20 26. A media server for supplying full motion video data, comprising:

means for processing user request data, said user request processing means being responsive to user request data for supplying information request data;

5 means for controlling sessions of said media server, said session control means being responsive to

said information request data for supplying information retrieval data and output control data;

10 data storage means responsive to said information retrieval data for supplying program data; and

 means for controlling the output of said media server, said output control means being responsive to said output control data for supplying said full motion

15 video data.

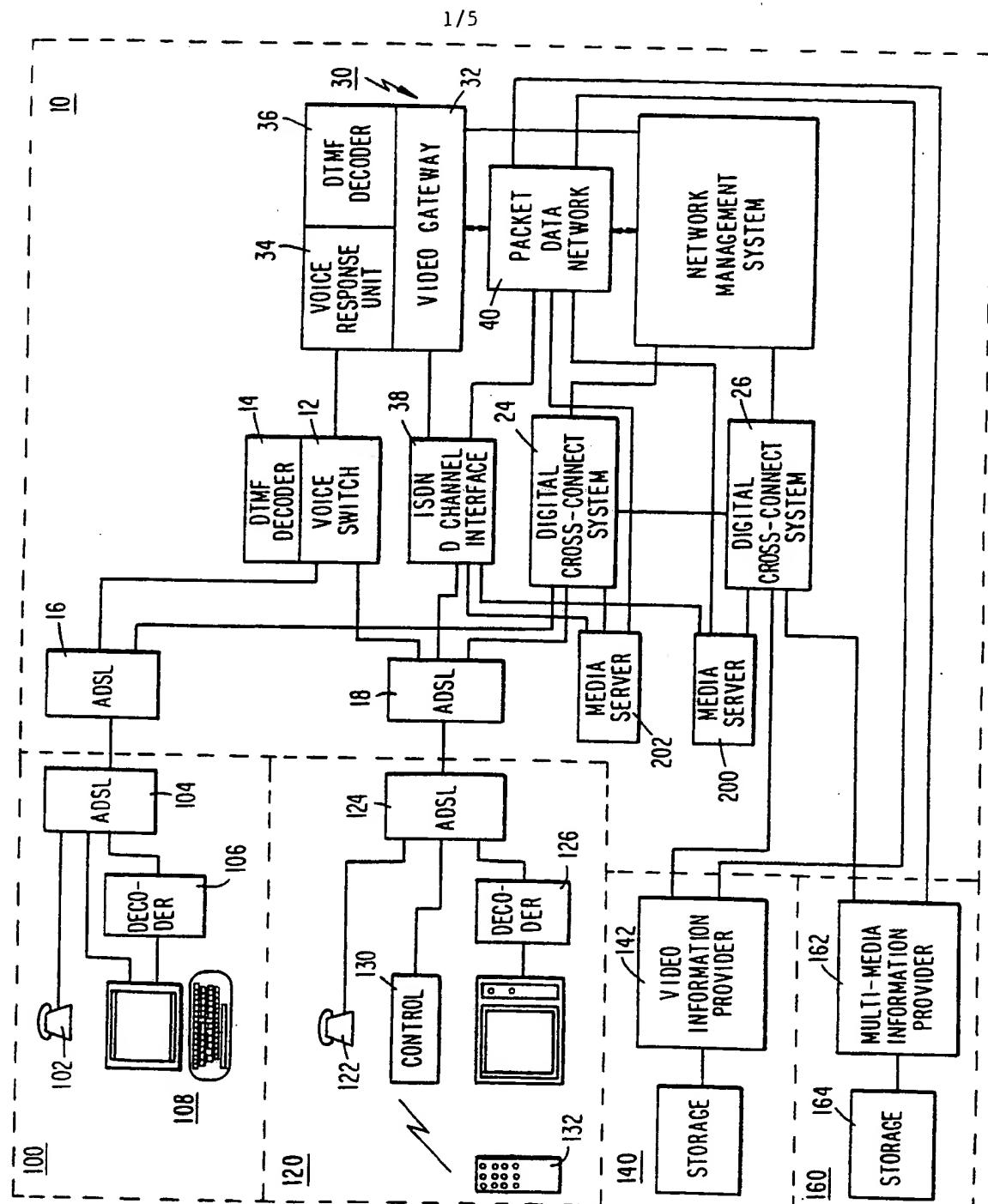


FIGURE 1

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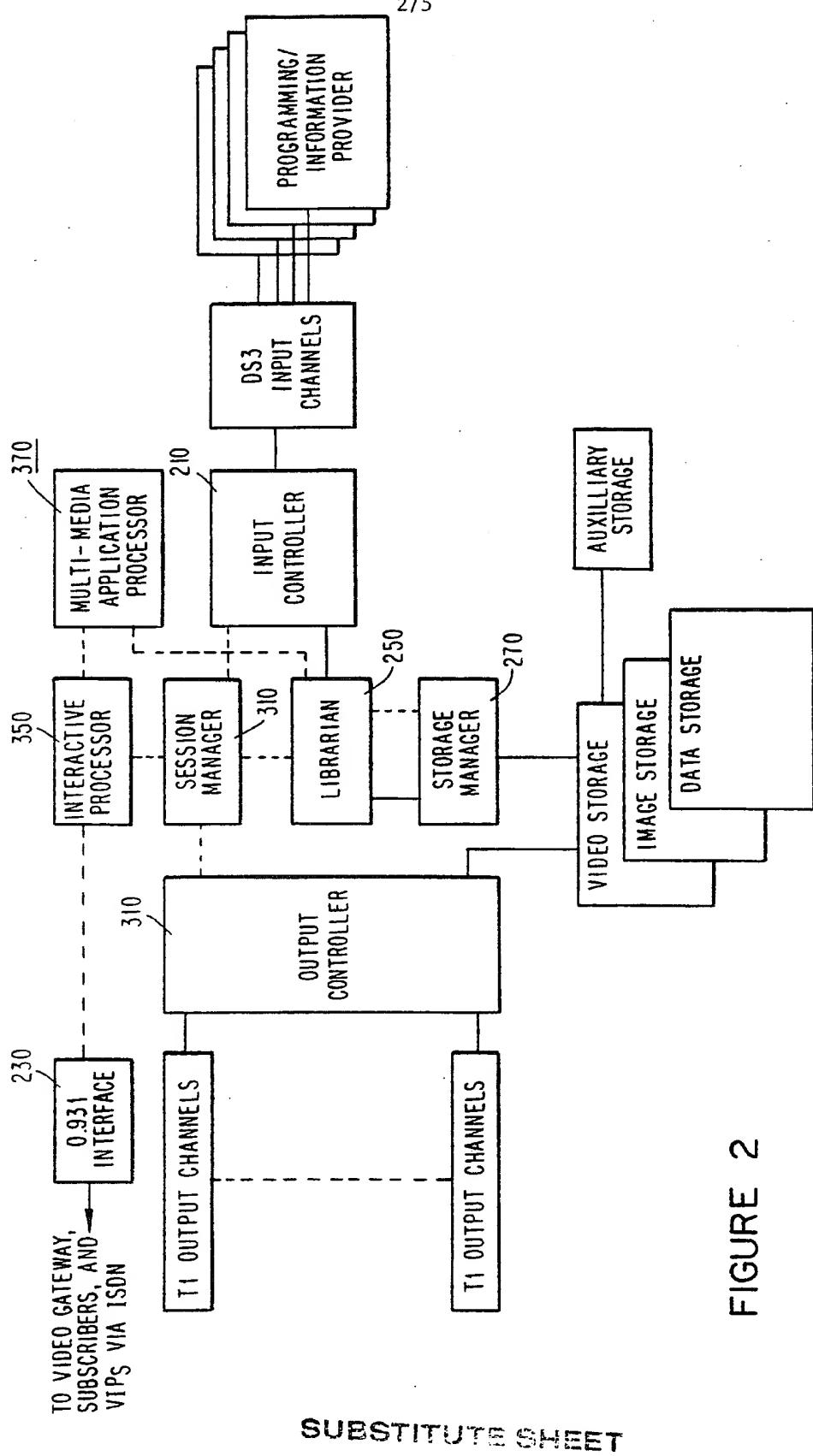


FIGURE 2

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FIGURE 3

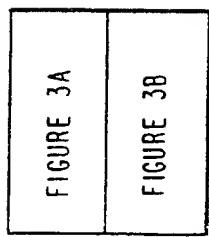
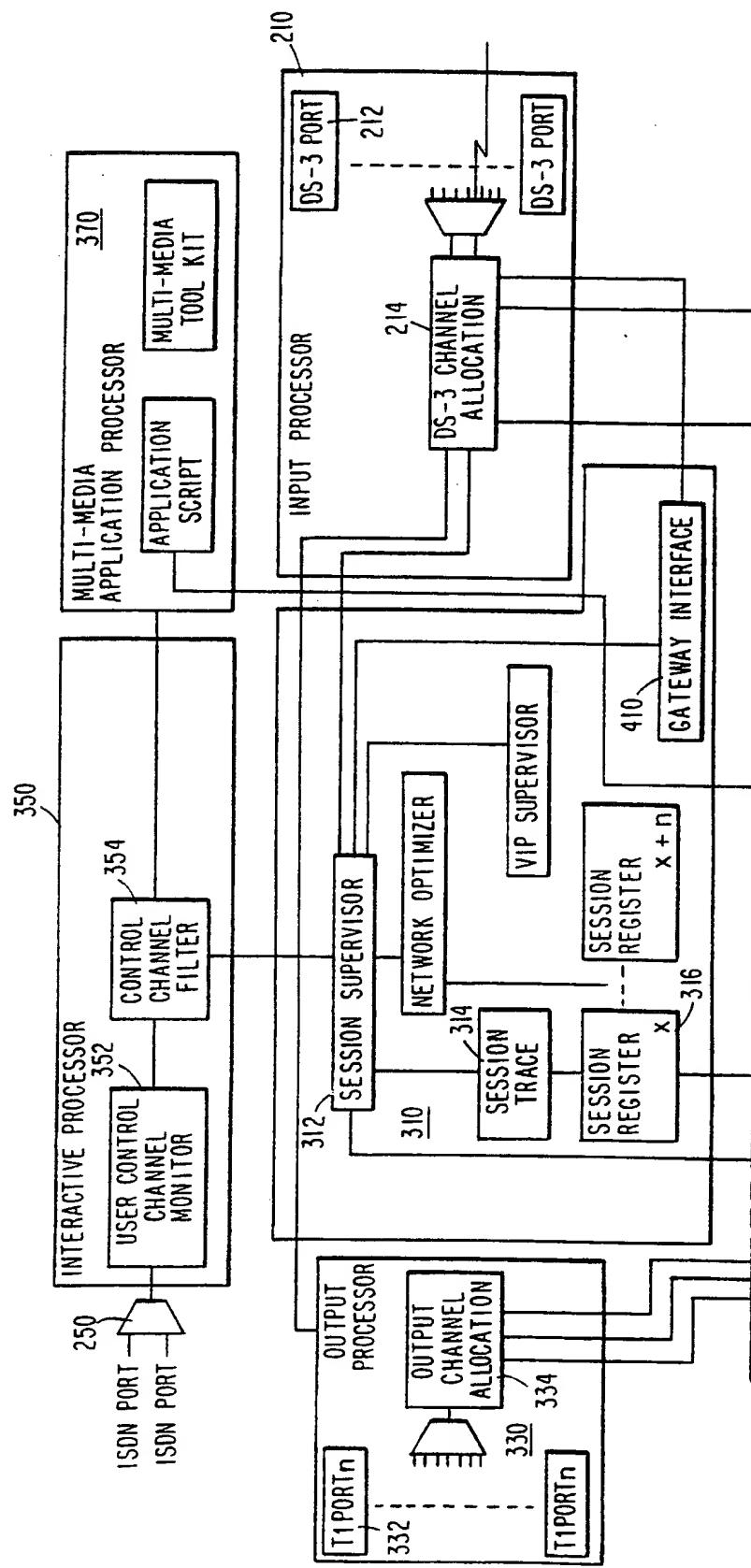


FIGURE 3A



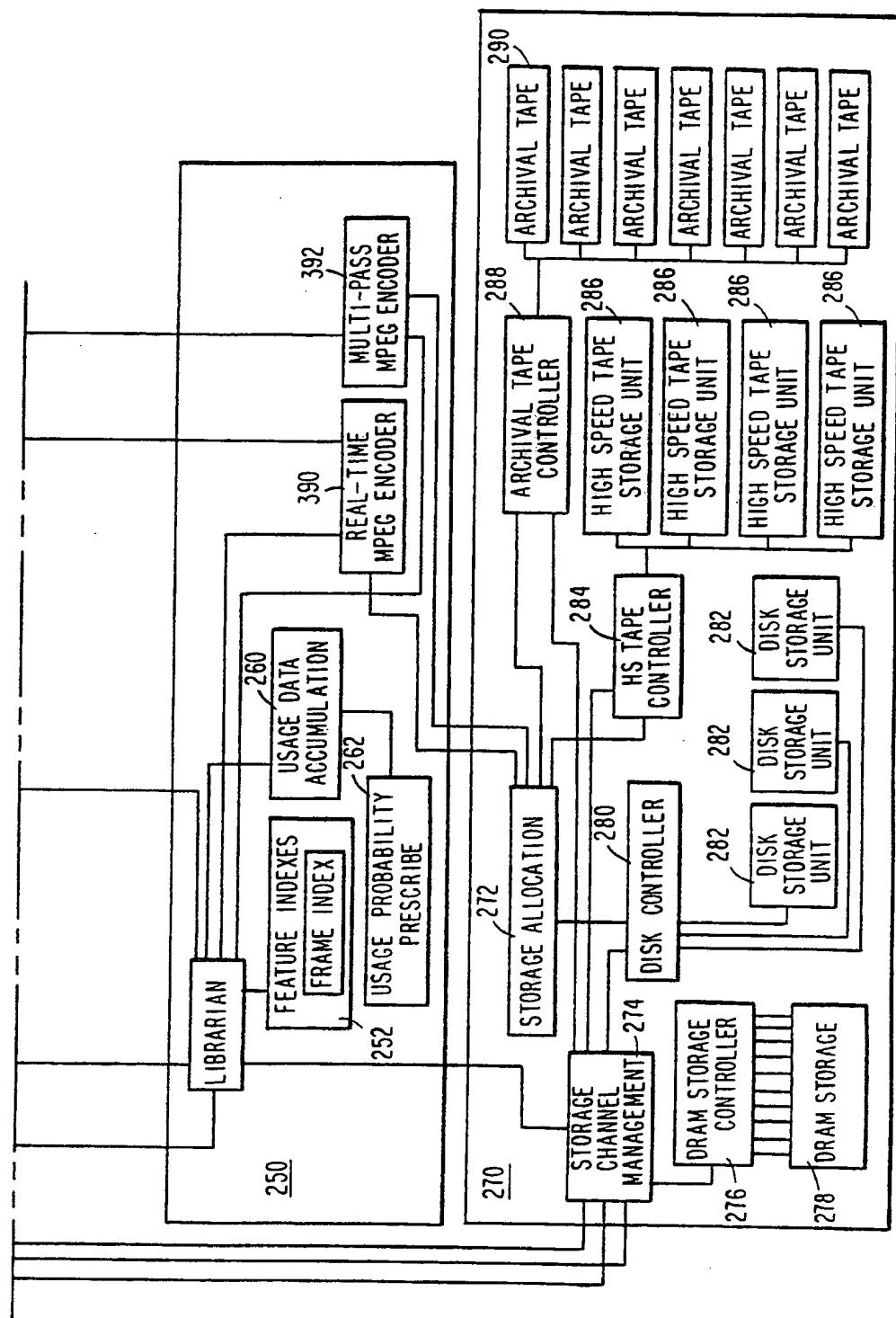


FIGURE 3B

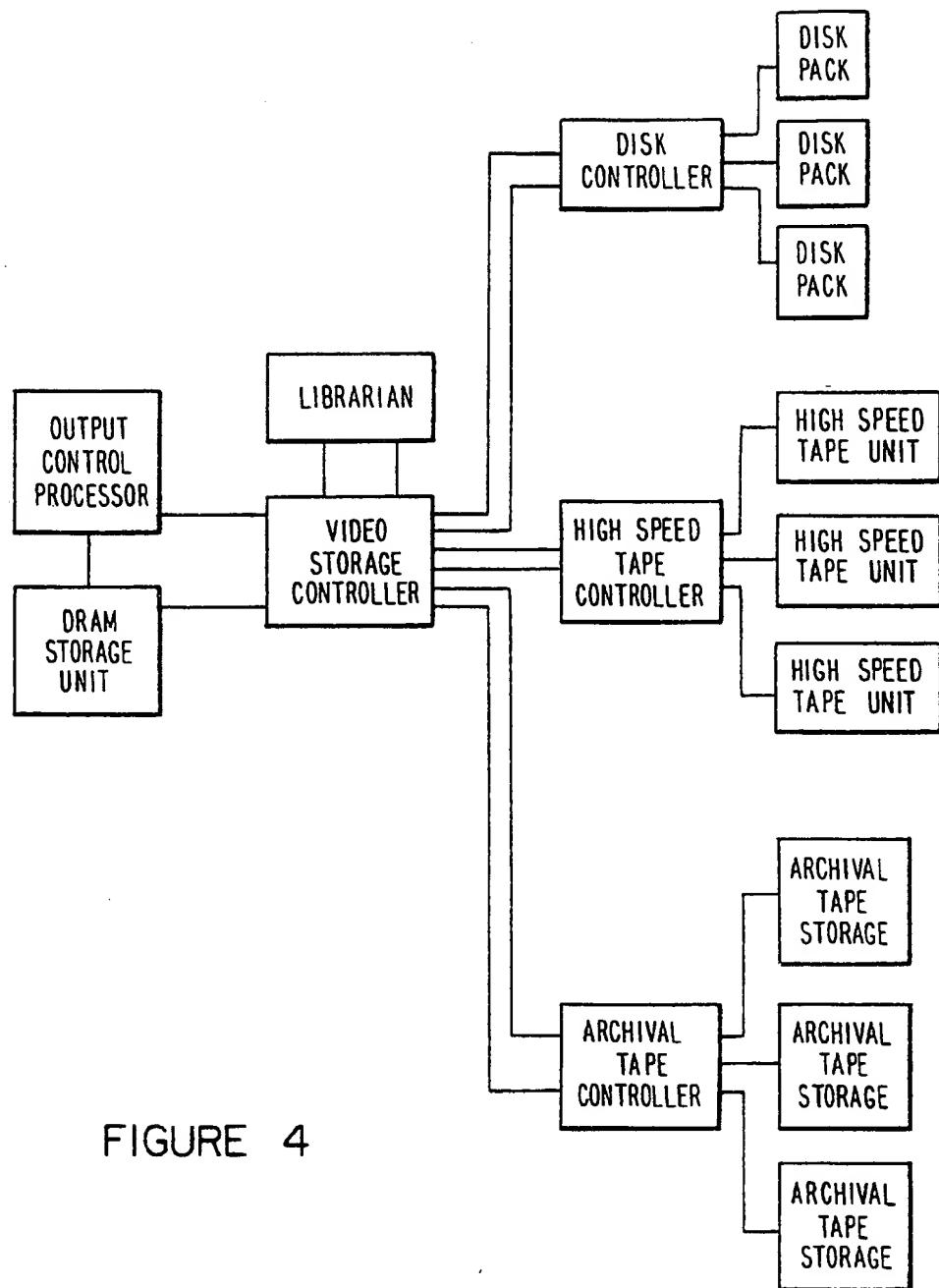


FIGURE 4

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INTERNATIONAL SEARCH REPORT

| |
|---|
| International application No. PCT/US93/05982 |
|---|

A. CLASSIFICATION OF SUBJECT MATTER

IPC(5) :H04N 1/00, 7/00, 7/10, 7/14; H04M 11/00
 US CL :358/84, 85, 86; 379/93, 96, 97, 98, 100

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 358/84, 85, 86; 379/93, 96, 97, 98, 100

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

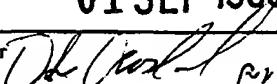
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|-----------|---|--------------------------|
| X | US, A, 5,027,400 (Baji et al) 25 June 1991, see the entire document. | 1-26 |
| A | US, A, 4,972,462 (Shibata) 20 November 1990, col. 5, line 60 through col. 9, line 51. | 1-8,13-17, 19, 20, 22-25 |
| A | US, A, 4,518,989 (Yabiki et al) 21 May 1985, col. 2, line 5 via col. 5 line 22. | 1, 2, 4-8, 13, 19, 22-26 |

Further documents are listed in the continuation of Box C. See patent family annex.

| | | |
|---|-----|--|
| * Special categories of cited documents: | "T" | later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention |
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| *O* document referring to an oral disclosure, use, exhibition or other means | "&" | document member of the same patent family |
| *P* document published prior to the international filing date but later than the priority date claimed | | |

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|---|---|
| Date of the actual completion of the international search 13 AUGUST 1993 | Date of mailing of the international search report 01 SEP 1993 |
| Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 | Authorized officer JIN F. NG  |
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